Class announcements

- Homework 3 due today
  - Late penalty for homeworks and folios:
    - full credit if handed in on the due date
    - 10% penalty if handed in up to one lecture late
    - 20% penalty if handed in up to two lectures late
    - no credit if turned in more than two lectures later
    - turn in on paper during the lecture; otherwise, your grade for that assignment may be delayed

- Midterm next Wednesday!
  - Study guide posted on class web site.
Today’s Class

- Review of HW 2 problem #1
- Midterm review part 2
- Review of data and information, architecture, and infrastructure
- The Internet
- Client server technology
- Student presentation of Sun N-tier
- Sun N-tier case discussion
Initial investment and return over time.
Net Present Value

$1$ invested in the bank today is worth $(1 + i)$ next year.

Equivalently: $1/(1 + i)$ today is worth $1$ next year.

$(1$ next year$)$ has NPV of $1/(1 + i)$

$1/(1 + i)$ == “discount factor”

Is this the same as your “personal discount factor”? 
*Net* Present Value
Net *Present* Value
Calculate ROR

- NPV = -900 + 750\times(1 + i)^{-1} + 350\times(1 + i)^{-2}

- NPV depends on the available interest rate.

- Rate of Return, r, is the interest rate that would make a bank investment equal in value:

- 900 = 750\times(1 + r)^{-1} + 350\times(1 + r)^{-2}
0 = 900 + 750*(1 + r)^{-1} + 350*(1 + r)^{-2}

Let \( d = (1 + r)^{-1} \)

0 = 350*d^2 + 750*d + 900

Use Quadratic Formula: \( d = -3 \) or \( 6/7 \)

Don't want negative interest rate! So, \( d = 6/7 = (1 + r)^{-1} \)

\( r = 7/6 - 1 = 1/6 \approx .1667 \). So, ROR is approximately 16.7%

16.7% > 15% So, go ahead with the project!
# Midterm Review Part 2

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<th>Pages</th>
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<td>Reader, R. Nolan</td>
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Midterm Review Part 2

- Porter Models
- Cisco Case
- Alibris Case
- E-Commerce
- More terminology
Porter Models

- **Five forces**
  - Buyers
  - Suppliers
  - New entrants
  - Substitutes
  - Rivals

- **Value chain**

- **Competitive strategies**
  - Primary
  - Supporting
Cisco Case

- Drivers of change
- Corporate strategy
- Vendor selection process
- Conference room prototyping
- Success factors
- Mistakes
- Lessons learned
O’Brien Framework and Cisco

- Management Challenges
  - Rapid growth
  - Failing systems
  - Cost overruns

- Specific Types of IT

- Business Applications

- Information Systems

- Developmental Process

- Foundational Concepts

- Process Tracks
  - CRP
  - RFP
  - BPR

- Manufacturing
  - Order entry
  - Finance
  - Sales

- Legacy systems
  - ERP

- Management philosophy
  - Cross-functional teams
  - Executive sponsorship
Alibris Case

Changes to Interloc’s revenue model?
Benefits of changing the revenue model?
Why the decision to switch to Oracle?
Benefits of the fulfillment facility?
E-Commerce

**Categories:**
- B2B
- B2C
- C2C

**Steps**
- Matching buyers and sellers
- Negotiating terms
- Consummation
- Customer service

**Procurement**
- Direct, indirect, EDI, SCM
## Review: terms to know

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
</tr>
<tr>
<td>NPV</td>
<td>Net Present Value</td>
</tr>
<tr>
<td>OLTP</td>
<td>Online Transaction Processing</td>
</tr>
<tr>
<td>BPR</td>
<td>Business Process Reengineering</td>
</tr>
<tr>
<td>ROI</td>
<td>Return on Investment</td>
</tr>
<tr>
<td>SCM</td>
<td>Supply Chain Management</td>
</tr>
<tr>
<td>IROR</td>
<td>Return on Investment Rate of Return</td>
</tr>
<tr>
<td>workflow</td>
<td>workflow</td>
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<tr>
<td>intermediary</td>
<td>intermediary</td>
</tr>
<tr>
<td>disintermediate</td>
<td>disintermediate</td>
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<tr>
<td>generation</td>
<td>generation</td>
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<td>regeneration</td>
<td>regeneration</td>
</tr>
<tr>
<td>replication</td>
<td>replication</td>
</tr>
<tr>
<td>representation</td>
<td>representation</td>
</tr>
<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
</tr>
<tr>
<td>LOB</td>
<td>Line of Business</td>
</tr>
<tr>
<td>ISV</td>
<td>Independent Software Vendor</td>
</tr>
<tr>
<td>end-to-end solution</td>
<td>end-to-end solution</td>
</tr>
</tbody>
</table>
Review: terms to know

Our model of information in a computer system has three essential components. Which of the following is not one of the three components?

(1) data
(2) structure
(3) relevance
(4) interpretation
An automatic teller machine (ATM) is an example of what type of application?

(1) DSS
(2) OLTP
(3) workflow
(4) SCM
Architecture

by

David G. Messerschmitt
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What is Architecture?

Structure and organizing principles of any system

What does that mean?

How do you architect a solution?

Understand the higher purpose of the system
Identify the basic elements of the system
Decompose into subsystems
Understand the functions and interactions of the subsystems
Orchestrate the emergence of the higher purpose
A system is decomposed into interacting subsystems

Each subsystem may have a similar internal decomposition

Slide adapted from slides for *Understanding Networked Applications*
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Three Elements of Architecture

- Decomposition - identification of interacting subsystems that make up the higher purpose of the system
- Functionality - capabilities assigned to each subsystem supporting the overall system purpose
- Interaction - how the subsystems communicate to support the system purpose
Emergence

Subsystems are more specialized and simpler functionality

Higher-level system functionality arises from the interaction of subsystems

Emergence includes capabilities that arise purely from that interaction (desired or not)

- e.g. airplane flies, but subsystems can’t
Why system decomposition?

- Divide and conquer approach to containing complexity
- Reuse
- Consonant with industry structure (unless system is to be supplied by one company)
- Others?
Architecture example: functional decomposition of an organization, through its org. chart

Vice Chancellor
Dr. Mary Doyle

Executive Functions:
Budgeting
Communications
Research

1. Applications and Project Management

2. Client Services and Security
   Security, Service Management, Support Center

3. Core Technologies
   Data Center, Enterprise Architecture, Network Ops, Telecom.

4. Client Relationship Management
   Divisional Liaisons, Local IT Specialists

5. Instructional Technology Group
   Five groups, including WebCT
Networked computing infrastructure

by

David G. Messerschmitt
Layering

“A specific architecture in which ordered subsystems interact only with their nearest neighbors. Used in the networked computing infrastructure, in which each layer makes use of the services of the layer below, adds elaboration or specialization, and provides services to the layer above.”
Example of Layering: networking

- Physical Layer
  - Bits
  - Signals

- Link Layer
  - Frames

- Network Layer
  - Packets

- Transport Layer
  - Messages

- Application Layer
  -
Software Layering

- Application
- Middleware
- Operating System
Operating system functions

- Graphical user interface (client only)
- Hide details of equipment from the application
- Multitasking
- Resource management
  - Processing, memory, storage, etc
- etc
Middleware Functions

- Capabilities that can be shared by many applications, but that is not part of OS
  - Example: Database Management System (DBMS)
- Hide details of OS from application
  - Java Virtual Machine
- More purposes we’ll talk about later.
The Internet

by

David G. Messerschmitt
Intranet

Private internet

Often connected to Internet

- Firewall creates a protected enclave
Extranet

An Extranet is composed of

- Intranets connected through an unprotected domain (typically the Internet)

- Encryption and other security technologies used to
  - protect proprietary information
  - prevent imposters, vandals, etc
Communication between intranets encrypted.
What is the Internet?

- An internet is a “network of networks”
  - Interconnect standard for LAN’s, MAN’s, and WAN’s
- Internet = the major global internet
- A private internet is called an intranet
- An extranet is an interconnection of intranets through the Internet
Network layering and the Internet

- **Application**
  - Messages
  - Server or client computer at network edge

- **Transport**
  - Packets
  - Internet routers, servers, clients

- **Network**
  - Frames
  - Internet routers, servers, clients, LAN hubs, LAN switches

- **Link**
  - Bits

- **Physical**
  - Signals

Protocols:
- TCP, UDP
- IP
- Ethernet, WiFi

Where used:
- Server or client computer at network edge
- Internet routers, servers, clients
- Internet routers, servers, clients, LAN hubs, LAN switches
Network layering and the Internet

- **Protocol**:
  - TCP, UDP

- **Network**:
  - IP
  - Ethernet, WiFi

- **Transport**:
  - Messages
  - Packets

- **Link**:
  - Frames
  - Bits

- **Physical**:
  - Signals

- **Companies**:
  - Sun, Microsoft, IBM, ...
  - Servers, client computers
  - Cisco, Huawei, Juniper, ...
  - Internet routers
  - Intel, Atheros, Broadcom, ...
  - Electronic hardware subsystems
Client - Server Computing
**The Basics**

- Users make demands on clients
  - A *client* interacts with *users*
    - Presents information
    - Collects information
  - A *client* interacts with *servers* to handle user requests
- *Servers* manage accept requests from clients and respond
  - Manage data repositories
  - Process data
  - Other services (storage, update, administration)
Simple Client Server Layers
Client examples

- Desktop (PC, Mac, other OS)
- ATM
- Airline check-in kiosk
- Price scanner
- Gas station terminal
- Smart phone
- Other??
Client Server Example

Client

“I want to see
www.google.com”

Server

Request from client to server

Response from server to client

<html><head><meta http-equiv="content-type" content="text/html; charset=UTF-8"><title>Google</title><style><!-- body,td,a,p,.h{font-family:arial,sans-serif;} .h{font-size: 20px;} .q{color:#0000cc;} //--> ...
<body>
Client Server Example - Layers Revealed

Client Application:

Server Application:

Internet

Packet Packet

Infrastructure

Packet Packet

Infrastructure
3-Tier Client Server Architecture example

Client

Clicks, keystrokes

Application Server

What is Bob’s balance?

$0.50

Shared data

What is Bob’s balance?

$0.50

Client

Balance $0.50
3-Tier Client Server Architecture example

- Client
- Application Server
  - Web Server
  - Application Logic
  - Common Gateway Interchange
- Shared data
3-Tier Client Server Architecture example

Client

Application Server

Web Server

Application Logic

Common Gateway Interchange

What is Bob’s Balance?

Database Management System (DBMS)

Database

Shared data
3-Tier Client Server Architecture example

Client

Application Server

Web Server

Java Servlet

Application Logic

Database Management System (DBMS)

Database

Shared data

What is Bob’s Balance?

In some implementations Application Logic and Web Server can be put on Different machines.
## Relational Database

<table>
<thead>
<tr>
<th>Customer</th>
<th>Balance</th>
<th>Customer Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>$527</td>
<td>Silver</td>
</tr>
<tr>
<td>Bob</td>
<td>$0.50</td>
<td>Bronze</td>
</tr>
<tr>
<td>Charles</td>
<td>$1000000</td>
<td>Gold</td>
</tr>
</tbody>
</table>
DBMS Responsibilities

- Hide Changes in the Database hardware from the Application

- Standard operations on the data, including searches, such a search is called a *query*.

- Separate Database Management from Applications, so that many applications can access the same data.

- Security, Integrity, Backup, fault tolerance, etc..
3-Tier Client Server Architecture in General

Client

- Accept instructions from user
- Make requests of server
- Display responses of server

Application Server

- Takes inputs from client
- Decides what to be done next
- Decides what shared data to access and manipulates it
- Processes shared data

Shared data

- Support multiple applications with common data
- Protect critical data
- Decouple data administration and application administration
E-commerce represented as a network of interactions involving consumers, enterprises, and financial institutions. The diagram illustrates the flow of transactions through various distribution centers or intermediaries, such as books4u.com, facilitating the exchange between consumers and enterprises, and between enterprises themselves.
Slide adapted from slides for *Understanding Networked Applications* by David G Messerschmitt. Copyright 2000. See copyright notice.
Peer to peer

- What is peer to peer good for?
Sun Case
Sun N-tier case

“...dominant player in powerful servers for the Internet and the exploding market for corporate intranets.” (p.1)

“last standing, fully integrated computing company” (p.2)
How Successful had Sun been up to 1998?

- Founded in 1982
- Open Standards Workstation
  - Unix Operating System (Solaris)
  - TCP/IP networking
- 1988 - Revenues $1 billion
- 1993 - Market value $3.0 billion
- 1997 - Jumped from 3rd to 1st in Unix Server Market.
How Successful had Sun been up to 1998?

- 1993 - “The network is the computer.”
- 1994 - Internet explodes in popularity
Microsoft mid to late 90s

- Dominated Desktop software
  - Users familiar with Windows, Office, etc.

- NT servers
  - Fine for small intranets, “not industrial strength”
IT Architecture I

Sun Microsystems
1. SPARC (processor)
2. Solaris (Multiuser, Unix-like OS)
3. Foothold in large server market
4. $1.3B Cash
5. “the better idea would ultimately prevail”

Microsoft
1. Intel (processor)
2. Windows (95, 98) single-user OS
3. NT Server (2000) finally a multiuser OS
4. $13B Cash
5. Bill Gates is confident that NT can be improved to “industrial strength”
## IT Architecture II

### Sun Microsystems
- Open Standards Strategy (TCP/IP, Java)
- Java (programming language)
- Java Virtual Machine (JVM) abstract away hardware and OS concerns
- Java Applets, Servlets, Webtop Computing
- N-tier Architecture (an idea or a product?)
- “Thin Client”
- Webtop computing
- More resource efficient engineering (software maintenance and support)

### Microsoft
- “Embrace and Extend” Strategy
- Kills Applets in IE (lawsuit)
- Total Cost of Ownership (TCO) $9900/PC
- “Fat Client”
- PCs are difficult to support
- Dominate Desktop (Office Suite)
- Domain-controlled networks (Server 2003/2007)

Who won? Who had the better idea?
What problems did the micro era produce?

- Desktops are expensive to maintain
  - TCO for windows PC $9900!

- Every PC had a lot of software that had to be maintained
  - Office, Windows, etc...

- Small differences, like the order in which software is installed, could make different PCs behave differently!
In the Networking Era

- These “bloated” PCs are networked and termed *fat clients*.
- But networking of PCs offered the possibility of
  - putting most of the functionality into servers
  - *Getting rid of much of the software on the client*
  - These clients would be called *thin clients*.
  - Sun, Oracle, and others saw it as the future.
Sun had the better ideas!

“Sun's goal was to create a fully developed network environment that could serve as a universal open standard for corporations that did not want to be tied to proprietary technology.” (p.13)

James A. Gosling, O.C., Ph.D. (born May 19, 1955 near Calgary, Alberta, Canada) is a famous software developer, best known as the father of the Java programming language.
Compiling C Code

- Library files are difficult to keep synchronized for all of the software on a system.
- This makes maintaining systems difficult.
- Each system becomes unique.
- N-tier architecture attempted to avoid this problem.

Java: “compile once, run anywhere”

- Actually in many cases, a program is distributed in the form of a JAR file, which stands for Java ARChive file.
Hardware for thin clients

- A **Network Computer** (NC) - a computer with minimal hardware that depends on a network connection to a server to function
  - Be careful not to confuse it with the phrase “networked computer!”
  - Example: Sun’s JavaStation (1996-2000)
  - It is the hardware one would use to implement a *thin-client* computing model.
  - TCO of $6,500 per year ($3,400 cheaper than a PC)
Another term from that era..

- A **NetPC** was a PC introduced by Microsoft and Intel in 1996
  - Same software as a normal PC
  - Did not allow users to install their own software
  - NetPC died out
  - Features of it, and Microsoft’s Zero Administration Kit, live on in today’s version of Windows.
Microsoft Vision

- Keep “fat-client” model
- Add some features to Windows to reduce administration costs
Microsoft is more successful...
Sun’s Vision

- Thin Client model.
- Application Servers with Applications written in Java.
- NCs could retrieve applications from application server as needed.
- Applications compatible with any NC hardware and OS.
- Applications could be fixed, added, updated at the server level, rather than maintaining each PC.
Java Applets

- Killed by Microsoft in IE by “embracing and extending” (lawsuit)
- Javascript (Unrelated to Java, Brendan Eich of Netscape 1995) becomes defacto standard for client-side programming
Q: You've been writing computer languages like Java. Do you envision a computer-language dislocation?

A: The common programming languages of C and C++ basically beached us. These languages are like whales. Sun and Microsoft maintain these monstrous C programs - Solaris and Windows NT - that are built out of materials that are very difficult to work with.
Windows NT 4.0 is 16.5 million lines of code that will never be debugged. It is infinitely complex. It is like having an elephant living in your apartment. The thing is just monstrous.

NT for consumers is an oxymoron because NT is basically mainframe software with all these windows and very little architecture. It is a mess.
Q: Yet NT is a hit. Everyone is moving on to it.

A: Many people were happy with the cars they bought from Detroit before Honda came along. I'd like to think that Java is more like when the Japanese came along with quality cars. With Java-based programming, instead of having one big system with infinitely complex buggy software, we can get a federation of machines working together to solve problems. The individual components are simpler. --interview with James Gosling
SUN 3 - Tier

Exhibit 1  Three-tier Architecture

Tier Three

Asia  United States  Europe

Tier Two

Tier One

JDBC: Stands for Java Database Connectivity. It is a programming interface that lets Java applications access a database via the SQL language.

RMI: Stands for Remote Method Invocation. It is the method by which a remote Java object from one location can be invoked from other Java virtual machines.

HTTP: Stands for HyperText Transport Protocol. It is the communications protocol used to connect to servers on the World Wide Web.
Sun N-tier
**Sun N-Tier**

**Step 1:** The user logs into his client and calls down an application. This message is sent to the Application Server.

**Step 2:** An initial applet is sent to the client. At the same time a servlet is sent to the Webtop Server.

**Step 3:** The applet talks back and forth with the Webtop Server via the LAN.

**Step 4:** As new data is received (i.e., a new customer’s name) the App Server communicates with the database to update that information.

**Remote:** The database and App Server communicate with the Webtop Server via a WAN.

**Local:** The Webtop Server and client communicate via a LAN.

*Exhibit 3 How the N-tier Architecture Works*
Sun’s Performance

Net Revenue

Net income
Sun’s Performance
Sun N-tier case
Today

- 3-tier model common.
- Sun’s version of 4-tier model not common.
- N-tier model where Webserver and Application Server on separate equipment also common.
- Sun’s hardware business not strong.
  - Linux on cheap PCs most common servers
  - Microsoft desktops replacing Sun workstations
Today

- **Java**
  - Common in Server implementations
    - Example: Java Servlet implementing application logic in a banking application.
  - Often used to push simple applets onto client
  - Not common
    - For “big” desktop applications
    - Office Suite in Java not popular
  - Microsoft is still in business...
1. How much time did Sun estimate developers could save when writing new applications by reusing Java objects?

2. Name one or two key differences between the 3-tier architecture and Sun’s 4-tier architecture.

3. What benefits are provided to Sun’s customers by the 4-tier architecture?

4. What is meant by a “high-latency servlet?”
Sun case - questions (2)

5 Bill Joy and James Gosling think Java is a superior programming language, but does Java have any weaknesses?

6 Which is more expensive: Sun's application server, or the ongoing maintenance of heterogeneous software applications on diverse platforms?

7 What advantage did Microsoft have over Sun in dealing with line of business managers in customer firms? (See p. 158)